03. AGRICULTURAL MICROBIOLOGY

Unit 1: History of Microbial World

History, development and scope of microbiology, evolution of microbial life. Theory of spontaneous generation. Prokaryotes, archaebacteria and eukaryotes. Techniques used in identification and classification of bacteria. Important groups of prokaryotes; photosynthetic bacteria; chemoautotrophic bacteria, spore forming bacteria, actinomycetes, heterotrophic bacteria, nitrobacteria, nitrogen-fixing bacteria, cyanobacteria, lactic acid bacteria, halophiles,thermophiles, acidophiles and methanogens. Structure and classification of viruses, bacteriophages/cyanophages/mycophages; growth of viruses, lytic and lysogenic cycles; plant viruses, viroids, prions and mycoplasma.

Unit 2: Microbial Ecology and Physiology

Principles of microbial ecology, Microbiology of ecosystems -soil, rhizosphere, rhizoplane, endorhizoaphere, phyllosphere, water: fresh and marine, and air. Microbial interactions - symbiosis, synergism, commensalism, parasitism, amensalism, antagonism and predation, adaptation of micro-organisms to various ecosystems. Microbial growth curve. Mathematical expression of growth-continuous and batch cultures. Diauxic and synchronous growth. Microbial nutrition. Bacterial metabolism -aerobic and anaerobic respiration, electron transport chain, metabolic pathways, microbial photosynthesis, oxidative and substrate level photo-phosphorylation, metabolism of xenobiotics, metabolism of C1 compounds. Biosynthesis of cell wall, protein, macromolecules (DNA/RNA), etc. by microbes. Molecular microbial ecology: numerical and molecular taxonomy and identification.

Unit 3: Soil Microbiology

Soil microorganisms: major groups, decomposition of organic matter, soil health. Root exudates (rhizodeposition) and rhizosphere effects. Exploration of rhizosphere microflora for plant productivity. Microbial biomass. Nitrogen cycle: ammonification, nitrification and denitrification. Biological nitrogen fixation-symbiotic, associative and a symbiotic. Biochemistry and genetics of nitrogen fixation. Microbial transformations of phosphorus, potassium, Sulphur and other minor nutrients. Role of biofertilizers in agriculture and forestry. Bioremediation of problematic soils, plant growth promoting rhizobacteria and their mode of action; Mycorrhiza and their associations. Formation and composition of soil organic matter: ferulic acid, fulvic acid and humic acid.

Unit 4: Environmental Microbiology and Basic Microbiological Techniques

Isolation and preservation of different types of microorganisms. Methods of sterilization and disinfection. Microscopy: Optical, bright field, phase contrast, fluorescent, dark field and electron. Microbial assay of vitamins, enzymes and antibiotics, Pollution of soil, water and air, Role of microorganisms in pollution remediation/amelioration; sources of pollution and their impact on environment, microbiology of sewage and industrial effluents and their safe disposal, management of solid and liquid organic wastes, composting, biogas, water purification, sewage treatment, water-borne diseases and effluent management.

Unit 5: Microbial Biotechnology

Industrial production of metabolites -organic acids, alcohols, antibiotics. Fermenter designs and types. Control of fermentation process -batch, feed batch and continuous. Downstream processing in fermentation industry. Production of single cell proteins and probiotics, hormones, biofertilizers, biopesticides. Phyto-remediation. Microbiology of raw and processed foods. Fermented food - vinegar, wine, sauerkraut, pickles, cheese, yogurt. Food preservation, contamination and spoilage, food-borne illness and intoxication. Food as substrate for micro-organism, microflora of meat, fish, egg, fruits, vegetables, juices, flour, canned foods; bio-degrading microbes, single cell protein for use as food and feed, bioactive food / probiotics.

Unit 6: Microbial Genetics, Genomics and GMOs

Genetic mechanisms in microorganisms, including bacteria, archaea, and viruses; principlesof genetic variation, gene expression, and genetic engineering techniques used in microbiology; Basic concepts of genetics: DNA, RNA, and proteins; Types of genetic mutations Mechanisms of genetic variation Methods of detecting and analyzing mutations; Transcription and translation in prokaryotes; Regulation of gene expression; Operon model and other regulatory mechanisms; Horizontal Gene Transfer; Bacteriophages and Genetic Exchange; Plasmids and Mobile Genetic Elements; Genomic Analysis and Bioinformatics; DNA extraction and purification; Polymerase chain reaction (PCR); Gel electrophoresis and DNA sequencing; Transformation and cloning experiments; CRISPR, Gene/Genome editing; Genetically modified microorganisms.